SCIENCECHRONICLES

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The Mission(s) of *Science Chronicles*:

1. To bring you the latest and best thinking and debates in conservation and conservation science;
2. To keep you up to date on Conservancy science — announcements, publications, issues, arguments;
3. To have a bit of fun doing #1 and #2.

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Conservation Future
Announcing 2013 NatureNet Science Fellows

By Bob Lalasz, director of science communications, The Nature Conservancy

Image: Conservancy scientist Stephanie Wear, a 2013 NatureNet fellow. Image credit: Karine Aigner.

Nine young scientists — with specialties ranging from energy infrastructure to urban ecology, Kenyan pastoral techniques to nanotechnology — have been named as inaugural NatureNet Science Fellows, a Nature Conservancy partnership designed to help kick-start conservation toward addressing the challenges facing people and nature in the 21st century.

"NatureNet Fellows builds on the Conservancy's deep tradition of partnering with the academy to bring the best possible science to conservation," said Mark Tercek, president and CEO of the Conservancy, which has joined with six of the world's premier universities — Columbia, Cornell, Princeton, Stanford, the University of Pennsylvania, and Yale — to establish the fellowships.

"The Conservancy is eager to take advantage of the fresh thinking the Fellows will bring to our work, especially as it enhances our positive impact on human well-being."

"These early-career scientists have outstanding skills and creativity in many of the areas conservation needs today," added Peter Kareiva chief scientist at the Conservancy. "These fellows will help the Conservancy lead in developing solutions relevant to the lives of billions of people on the planet."

The fellows begin their two-year assignments this fall, working within the Conservancy's U.S. and international programs. Jointly mentored by a Conservancy

expert and a senior scholar from one of the partner universities, each fellow will pursue research that promises to deliver crucial answers around sustainable food production systems, clean water supplies, energy futures, and urban ecology.

"I feel extremely excited and privileged to be part of the first cohort of NatureNet Science fellows," said Wilfred Odadi, whose NatureNet fellowship project will focus on developing smart livestock grazing management and off-take strategies in northern Kenyan rangelands. "This fellowship provides me with a perfect opportunity to conduct research that could potentially significantly contribute towards enhancing human livelihoods while conserving the natural environment."

"With NatureNet Fellows, The Nature Conservancy signals to the world that conservation now needs to base its work not just in ecology and biology, but in an interdisciplinary approach to science and evidence," added Roy Vagelos, a founding funder of the NatureNet Fellowship program, a member of the Conservancy's board of directors and a former president, CEO and chairman of Merck & Co.

"I'm looking forward to seeing the fellows push the Conservancy in new and necessary directions as it works to solve global sustainability challenges around energy, water and agriculture."

The 2013 NatureNet Science Fellows and their projects are:

1. Dan Auerbach, Cornell, water funds
Explore and implement methods for water fund assessment and prioritization to help determine where and how conservation investments should be made to yield the greatest returns in water quality and quantity. Mentors: Alex Flecker (Cornell), Heather Tallis, (The Nature Conservancy).

2. Daniel Karp, Stanford, agriculture and conservation
Develop strategies for reconciling conservation with agricultural production, particularly through a predictive framework for how biodiversity-driven ecosystem services change in farming landscapes. Mentors: Mary Ruckelshaus (Stanford), Peter Kareiva (The Nature Conservancy).

"With NatureNet Fellows, The Nature Conservancy signals to the world that conservation now needs to base its work not just in ecology and biology, but in an interdisciplinary approach to science and evidence."

3. Rob McDonald, The Nature Conservancy, urban conservation
Develop a conceptual framework that shapes "conservation for cities" and then communicate this framework to a broad audience of urban planners, municipal officials, conservation practitioners, and academics. Mentors: TBD.

4. Joanna Nelson, Stanford, water funds
Contribute hydrological modeling tools and expand current monitoring strategies so that water funds can be held accountable for delivering on their promise of cleaner water through conservation. Mentors: Mary Ruckelshaus (Stanford), Adam Freed (The Nature Conservancy).

5. Wilfred Odadi, Princeton, Kenyan pastoralist sustainability
Develop smart livestock grazing management and off-take strategies that enhance pastoral livelihoods and environmental conservation in northern Kenyan rangelands. Mentors: Dan Rubenstein (Princeton), Tim Tear (The Nature Conservancy).

6. Efrat Sheffer, Princeton, agriculture, biodiversity and nitrogen
Explore how landscape-scale interactions between agricultural systems, abandoned fields and natural ecosystems affect biodiversity and local-scale nitrogen cycles—and determine the consequences of these interactions for downstream pollution or even "dead zones." Mentors: Simon Levin (Princeton), Giulio Boccaletti (The Nature Conservancy).

7. Anne Trainor, Yale, energy infrastructure and nature
Provide the means to implement future energy infrastructure —both traditional and renewable — across a variety of landscapes while minimizing impacts on ecosystems and biodiversity. Mentors: Oswald Schmitz (Yale), Joe Fargione (The Nature Conservancy).

8. Stephanie Wear, The Nature Conservancy, oceans and wastewater
Identify and bring together solutions to address water quality issues in ways that benefit both public health and coastal habitats. Reducing sewage is good for reefs and people. Mentors: TBD.

9. Sen Zhang, University of Pennsylvania, nanotechnology and sustainable energy
Develop nanotechnology for efficient and sustainable sources of energy and fuel. Mentors: Chris Murray (Penn), Jimmie Powell (The Nature Conservancy).

"NatureNet Science Fellows is a unique collaborative program where fellows from a select number of our major research universities and leading conservation NGOs like The Nature Conservancy embark on a interdisciplinary program to pursue practical solutions to our most critical conservation and environmental issues," said Steven A. Denning, co-chair of the Conservancy's board of trustees and a founding funder of the NatureNet program.

"This fellows program is combining the best of both academia and action-oriented NGOs to generate the sort of conservation science breakthroughs that can offer implementable solutions to our most pressing environmental challenges."

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We will report on the progress of the fellows' projects on Cool Green Science. To learn more about the NatureNet Science Fellows Program and its university partners or how to apply for next year's fellowships, go to the NatureNet Science Fellows homepage. SC

Peter Kareiva
Are We Thinking Globally When We Do Conservation?

By Peter Kareiva, chief scientist, The Nature Conservancy

Image: Think globally, act locally. Credit: Flickr user Vlasta Juricek via a Creative Commons license.

Renowned fisheries scientist Ray Hilborn recently wrote an article questioning whether marine protected areas are all that they are cut out to be when you take a global view (Hilborn, 2013). He pointed out that while Australia may have done a wonderful job setting up its own marine protected areas, it still consumes a lot of fish, and imports 85% of that fish. Most of Australia's fish imports are from capture fisheries or aquaculture in Vietnam, China and Thailand. Thinking globally, would it be better for Australia to have less of its own coastal waters in no-take zones and have well-managed Australian fisheries, or alternatively rely on these imports from Asia where the environmental impacts may well be quite damaging?

The same reasoning can be applied to other conservation actions. In 2011, Eric Lambin and Patrick Meyfroidt (Lambin and Meyfroidt, 2011) pointed out that lands designated as nature preserves are lands that cannot yield timber or food, and that in turn may require increases in timber and food imports. Taking this one step further, importing agricultural and timber products often amounts to exporting land conversion to some other country. For example, between 1990 and 2004, countries that enacted conservation set aside policies increased their cereal imports by 42% compared to an average 3.5% increase among countries that did not pursue conservation set asides. Vietnam has been reforesting since 1987, but it has been doing so by importing

more wood, half of which is illegally harvested.

None of this is to argue against protected areas or countries that do a good job taking care of their own lands and waters. The key lesson is to realize when we impose strong conservation policy in one country, there is almost always leakage of our impacts, such that protected areas set up in one country may simply mean damage is done elsewhere. That leakage can be minimized by increased efficiencies and technology.

Ultimately, with another 3 billion people to be added to the planet, it should be obvious that any global solution must combine altered consumption patterns, increased efficiencies and new technologies that substitute renewables for fossil fuels, find building materials that do not require cutting down forests, and identify protein sources that do not require vast amounts of land.

It could be that conservation's best friend will be massive single-species plantations of rapidly growing trees, large-scale and high tech fish farms, and industrial agriculture. These are exactly the opposite of what we find glorified in our local farmer's markets, with wild fish, and locally organically grown vegetables. If land is in short supply, and it is, then both marine and terrestrial conservation need to think about what is the best way to get the food and timber we need with minimum global conversion of forests.

Conservation is driven and supported by those of us with a passion for our favorite local habitats and retreats, the best hikes in the Cascades or the Smokey Mountains, the Pacific reef we once snorkeled. Land trusts, from whence TNC was born, are all about local actions. But now that we are interested in the global environment, we need to have a global understanding of the consequences of all of our local actions. **SC**

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"It could be that conservation's best friend will be massive single-species plantations of rapidly growing trees, large-scale and high tech fish farms, and industrial agriculture."

Head-to-Head
A Debate about Randomized Control Trials in Conservation

By Craig Leisher, senior social scientist, The Nature Conservancy, and Eddie Game, conservation planning specialist, The Nature Conservancy

Image: Rooster fight in Indonesia. Image credit: Flickr user Rene Bastiaanssen via a Creative Commons license.

In the medical field, randomized control trials (RCTs) are widely used to eliminate bias and demonstrate causality. Does a certain medication actually work, and will it work across all populations of people? To answer these questions, medicine has relied on RCTs for the past 50 years. But are RCTs an effective way to measure the success of conservation strategies? Does conservation *need* RCTs?

Craig Leisher advocates for RCTs, saying they can help show that conservation strategies actually benefit people. **Eddie Game** argues that RCTs are unrealistic and unnecessary for conservation.

Read their views on the following pages, then weigh in with your own opinion by taking this short survey.

We Need to Step Up to the Gold Standard of Impact Evaluations

By Craig Leisher

Would you believe the industry-funded Tobacco Institute when it stated, "Causality has not been proven in any of the diseases and conditions linked statistically with cigarette smoking"? Probably not because we know it's biased, and bias matters in science — just ask a climate scientist about WWF predictions on the melting of Himalayan glaciers.

Bias in a scientific study is often subtle yet can have an oversized impact on the results. A small bias, for example, in who participates in a study can skew the results. To reduce the potential for bias in a study, researchers often randomly select the study participants. Bias, however, is not the only subtle factor that can influence a study's results. There are a multitude of potential external factors that can also muddle the results.

In the mid-20th century, the medical field developed an elegant study design that can address bias and external confounding factors: randomized control trials or RCTs.

The way an RCT works is a group is randomly selected from a population and then randomly assigned to a "treatment" or a "control" group. The law of large numbers says the averages of the treatment and control groups will be similar to the overall population and to each other. This greatly reduces biases and all known and unknown confounding factors.

RCTs are the force behind most of the major advances in medicine in the past 50 years and are the gold standard of evidence in medicine, education and agriculture. But not yet in conservation.

Conservation today is where medicine was 50 years ago. We believe we know what works, but we don't test our strategies in a rigorous way to see if this is so. If we keep our heads buried in the sand about rigorous impact evaluations, the evidence that conservation benefits not only nature but also people will remain elusive.

The MIT Jameel Poverty Action Lab (J-PAL) has completed more than 350 RCTs in the last 10 years, and staff at J-PAL are eager to partner with the Conservancy to help us answer big questions about social impacts and cost effectiveness, such as: Do community grazing management plans equitably benefit herders, or which fisheries management tools produce the most benefits to fishers? They see the environment sector as promising for RCTs given the scarcity of rigorous impact evaluations and the large resource flows.

Should we say "no" or should we say "yes" to the rigorous testing of our strategies?

It's not an easy "yes." There are valid concerns about RCTs, but they can be

addressed. This is why the World Bank, USAID, AusAID, DFID, NORAD, and the Gates Foundation all support the use of RCTs to evaluate impact. To compete in the marketplace of strategies for improving people's lives, conservation needs the rigorous evidence only RCTs can provide.

Why RCTs Are Not the Answer for Conservation

By Eddie Game

RCTs are the gold-standard for demonstrating causality. This I do not dispute. What I dispute is that RCTs are a critical evaluation tool that conservation should rush to apply. I doubt that:

a) RCTs are generally realistic in conservation;
b) the results from RCTs are generalizable in a useful way; and
c) this is the standard of evidence/evaluation expected by conservation funders.

The world is not a laboratory and it is neither possible nor ethical to control the development assistance that communities receive; you can only control what you do. To overcome this inevitable uncontrollability, RCTs rely on inclusion of a large number of replications. Proponents of RCTs always site their impact in medicine. However, in order to ensure that treatment and control groups are statistically similar enough (because individuals vary in physiology and behavior), countries like Australia and the U.S. insist that treatments in clinical RCTs are repeated several thousand times! This might be feasible for treatments whose unit of replication is a person or a household (say distributing bed nets or administering some drug), but we rarely replicate water funds, MPAs, grazing management, or any other conservation treatment at the scale of a household (and where we do, it usually means the landowners are wealthy and therefore unlikely to be the target of a livelihood-based project).

What's your view of piloting RCTs in conservation: positive, negative or neutral? Click here to vote or leave a comment.

Ah, but surely we can ask hundreds of households in the same water fund catchment whether the project has improved their well-being? This is known as pseudoreplication, a common trap for conservation's RCT advocates. Pseudoreplication occurs when multiple samples from a single treatment unit are analyzed as if they were independent replicates and the results are then used to infer treatment effects. To use the apparently popular medical analogy, imagine you wanted to know the effect of building a hospital on community health. The treatment is the hospital, not the care individuals experience when they go there. Surveying lots of individuals in the community where the hospital was built helps increase our confidence in any trend we see, but to know the effect of the hospital you need to look at lots of communities with new hospitals. It is the same with conservation projects.

The random assignment of participants to treatment or control groups is also a problem. The reality is we do not choose communities to work with randomly because biodiversity and willingness to work with us are not distributed randomly. We very intentionally try to identify communities where there is interest and willingness to

work with us, and therefore introduce a number of biases. We could do as they do in medical RCTs and ask communities to agree to participate and then only undertake the interventions in a randomly selected subset of these, but how much good faith would this burn through?

RCTs are about proving or disproving a causal relationship that is hypothesized and can subsequently be generalized. Conservation's RCT supporters often claim we should use them to rigorously test our strategies so we can replicate them with confidence. However, conservation projects are not well suited to generalizable claims from RCTs. In a variation on the philosopher Nancy Cartwright's critique of RCTs, what RCTs tell us is "it worked somewhere," and yet we often read the results as "it will work for us." Conservation outcomes depend on complex local interactions, and it can be difficult to distinguish between the role of the strategy and the group implementing it.

For example, in Melanesia there have been high-profile examples of conservation organizations catastrophically failing at the same intervention that others have implemented successfully. Social-ecological systems are dynamic, they mutate and change. Generality can be achieved through lots of RCTs on the same intervention, which for some strategies (say MPAs) might be possible, but where you have an intervention repeated so many times there are also other less burdensome statistical approaches to deriving generalities about impact.

Which brings me to my third and final point. If the results of RCTs are not generalizable and therefore only useful for evaluating the effectiveness of a particular project, their principal role is in reporting to funders and justifying the continuation of funding. I argue that these ends can usually be accomplished without the heavy financial or logistic burden of an RCT. Many (but certainly not all) donors rightly want evidence that the objectives you are trying to achieve are moving in the right direction. Yes, knowledge that the strategies you undertook were the principal cause of this is ideal, but I have rarely seen it insisted upon — experience suggests most people are happy with a well-demonstrated trend in the right direction!

Data-driven monitoring and decision-making are critical for improving conservation, but there are more viable, less intensive tools than RCTs.

What's your view of piloting RCTs in conservation: *positive, negative or neutral? Click here to vote or leave a comment.* **SC**

Elizabeth Mcleod
Tackling Ocean Acidification: Global Warming's Evil Twin

By Elizabeth Mcleod, climate adaptation scientist, The Nature Conservancy

Image: Coral showing early signs of bleaching in Palau. Image credit: Ian Shive.

Many of you have probably read about ocean acidification and rolled your eyes – another global stressor threatening the extinction of coral reefs around the world. Throw this into the mix with increased sea temperatures, pollution, sedimentation, overfishing and we have a fabulous soup of overwhelming threats, many of which feel as if they are beyond the scope of what can be managed.

Ocean acidification is often referred to as the 'evil twin of climate change' because it occurs independently from, but with, climate change. It refers to a decrease in ocean pH caused primarily by uptake of atmospheric CO_2. Because human activities (e.g., burning of fossil fuels) are releasing CO_2 into the atmosphere very quickly, the ocean is taking up CO_2 faster today than it has in the past which is causing the chemistry of the world's oceans to change more quickly than they can handle.

When atmospheric CO_2 dissolves in seawater, ocean pH decreases (making it more acidic) and carbonate ion concentration decreases (making carbonate ions unavailable to marine calcifiers such as corals, coralline algae, crabs, clams, oysters, and some plankton). Ocean acidification often leads to reduced calcification and enhanced dissolution of marine calcifiers, which can have major implications for marine food webs and commercial fish stocks, threatening the food security of millions of people.

But now, the good news: we are on the cusp of developing and implementing strategies to help managers address ocean acidification. Here are some key questions marine scientists are struggling with and progress we have made.

Should we give up and throw in the towel?

In a word, "No." Why? First of all, because I am a die-hard optimist, and if I wasn't, I would not have spent the last ten years of my life working to protect coral reefs.

I realize that's not a very scientific answer.

But if we look at the scientific evidence, we should also answer "no" because research demonstrates significant variation in the sensitivity of marine organisms to ocean acidification. Calcifying organisms typically exhibit larger negative responses than non-calcifying organisms and variation in response to ocean acidification has been observed among species and also during different developmental stages.

Scientists have also discovered that local characteristics (e.g., oceanographic patterns, benthic community composition) can drive major changes in ocean chemistry at multiple scales; natural variability in seawater acidity is strong over days, weeks and months and this variability can be much larger than the projected changes in acidity over decades to centuries.

This means that in some areas of the ocean, organisms are already experiencing fluctuations in ocean chemistry and some organisms are able to handle these changes. How these organisms will respond to future changes is unknown, but exploring these areas will help us to understand the potential for acclimatization and adaptation.

"This means that in some areas of the ocean, organisms are already experiencing fluctuations in ocean chemistry and some organisms are able to handle these changes."

Do we know enough to take action now? What have we learned from studying coral bleaching?

Do we know enough to change the way we design and manage our protected areas to address the threat of ocean acidification? Well, we have developed some important hypotheses that suggest that we are not far off, based on how we manage our reefs in the face of ocean warming.

Management approaches that support resistance and resilience to coral bleaching have only recently been implemented and have yet to be tested by major bleaching events, so their effectiveness cannot yet be determined for many coral reef areas. Three key components that have been identified to increase a reefs' ability to resist or recover from thermal stress: (1) spatial risk spreading, (2) management for maximum connectivity within networks of source and sink reefs, and (3) better management of

local-scale stressors to enhance reef resilience. (This work has been pioneered by Rod Salm in our Asia Pacific Program.)

These same principles could also be applied to address ocean acidification, given that reefs impacted by this stressor are expected to be more vulnerable to coral bleaching. Additional considerations for acidified reefs could include:

- closely monitored management of herbivore fishing, as faster growing algae will be more likely to outcompete slower growing corals in acidified seas;
- protection of reefs with low risk of exposure to storms, as coral growth and resilience will be reduced; and
- MPA designs that include shallow-water coral communities surrounded by seagrass beds to counteract local acidification.

Management strategies to address coral bleaching also focus on identifying local environmental factors that provide natural protection against bleaching; identifying and protecting coral species that are more resistant or better able to recover from thermal stress (e.g., based on different susceptibilities or acclimatization mechanisms); and using climate models to identify those reef areas with the highest probability of escaping the worst effects of warming.

If we apply these principles to ocean acidification, we need to identify and protect marine species that will be less exposed or sensitive to changes in ocean carbonate chemistry (e.g., reef areas likely to experience less change in seawater chemistry as oceans acidify due to their ability to modify the seawater chemistry via high rates of photosynthesis and local drawdown of CO2; reef communities with physiologically resistant species), or which have a high adaptive capacity. Coral reefs in areas already experiencing naturally high fluctuations in ocean chemistry have adapted to deal with these conditions, and might represent priorities for protection.

Although the science is developing, uncertainties exist regarding how marine species and communities will respond to ocean acidification and which reefs are more or less vulnerable to ocean acidification. Until we are able to better understand these differences in vulnerability, it is important to apply a "bet-hedging approach." For example: protect reefs in areas with high and low variability; select reefs in a variety of pH and aragonite saturation regimes to increase the chances that managers will protect corals that are acclimated to a variety of pH conditions and spreads the risk of any coral species' survival being compromised by ocean acidification.

"Coral reefs in areas already experiencing naturally high fluctuations in ocean chemistry have adapted to deal with these conditions, and might represent priorities for protection."

What are we doing now?

To refine our hypotheses, we decided to pull together some of the best acidification researchers in the world so we held a workshop and invited global experts from the National Center for Atmospheric Research, Woods Hole Oceanographic Institution, Australian Institute of Marine Science, University of Queensland, James Cook University, SCRIPPS, Stanford, University of Miami, NOAA, and the Great Barrier Reef Marine Park Authority.

We brought this group together in Palau with marine conservation planners and managers to identify:

1) factors likely to affect coral reef ecosystem vulnerability to ocean acidification, and
2) knowledge gaps and research priorities needed to integrate vulnerability to ocean acidification into conservation planning and management.

We wanted to expose the researchers to a variety of different coral reef environments with varying water circulation patterns and influences of terrestrial water run-off and related chemistry so we could begin to make predictions about coral growth and density in the face of changing ocean chemistry and design research projects to test and refine these predictions.

A major goal of this effort was also to catalyze partnerships among researchers, conservation practitioners, and the Palau International Coral Reef Center. This group committed to help design and implement a targeted Ocean Acidification Research and Adaptive Management Program. Our plan was to first test these ideas in Palau and then integrate them into our work in the Coral Triangle and beyond.

At our Palau workshop with ocean acidification researchers and coral reef managers, we identified 5 research priorities needed to incorporate ocean acidification into conservation planning and management:

1) establishing an ocean carbon chemistry baseline,
2) establishing ecological baselines,
3) determining species/habitat/community sensitivity to ocean acidification,
4) projecting changes in seawater carbonate chemistry, and
5) identifying potentially synergistic effects of multiple stressors.

"At our Palau workshop with ocean acidification researchers and coral reef managers, we identified 5 research priorities needed to incorporate ocean acidification into conservation planning and management."

Based on these five priorities, we are currently working on developing a research plan (e.g., development of spatial vulnerability maps, identification of refugia, identification of how ecosystem services can be affected by ocean acidification and refinement of MPA design principles in light of ocean acidification) and are seeking sources of funding to continue this work.

What next?

To date, few ocean acidification studies have been designed to address conservation planning and management priorities. To address this, we have invested time and resources in bringing together ocean acidification researchers with conservation planners and managers in a series of workshops and collaborative publications (Mcleod et al. 2012a; Mcleod et al. 2012b; Rau et al. 2012; Friedrich et al. 2012; McLeod and Anthony 2012; Mcleod et al. 2008). The partnerships we have built have already led to some exciting developments. For instance, researchers from Woods Hole Oceanographic Institution have raised over $900,000 to continue ocean acidification research in Palau and other reef systems across the global tropics aimed at identifying

naturally resistant/resilient coral communities and the mechanisms underlying that resilience.

Significantly, and as this example demonstrates, we learned that a small investment of catalytic funding can lead to sustained long-term investment to address urgent threats to our marine environment. By working to build the capacity of our partners, we can process and share these lessons across other areas to improve the survival prospects of coral reef ecosystems and dependent communities across the tropics.

Consistent with the Asia Pacific Region's new direction and approach, one of our primary objectives and strengths is to identify and support cutting-edge science, despite the challenges of our current financial climate. Based on our efforts, we at TNC are now looked to as leading the way for how NGOs are addressing ocean acidification impacts and responses in the marine environment. We must continue to push the science forward to support our conservation objectives. **SC**

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"By working to build the capacity of our partners, we can process and share these lessons across other areas to improve the survival prospects of coral reef ecosystems and dependent communities across the tropics."

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Article
Hunting and Conservation: A Personal Perspective

By Mike Palmer, program officer, The Nature Conservancy in Canada

Image: Mike Palmer scans the Mackenzie Mountains in search of sheep. Image credit: Lindsey Cymbalisty.

We were 200 kilometers from the nearest human as we touched down in the Cessna 206 on a small mountain lake in the Mackenzie Mountains of Canada's Northwest Territories. The flight had been bumpy as we slid over mountain tops and braided rivers, ending with the pilot flying a few loops to check the lake surface before landing.

"Do you want to see anything else?" he asked over the radio.

"No, let's just land." My head and stomach said I needed solid ground. My hunting partner, Lindsey, was wedged in the back of the plane between backpacks and rifle cases, probably thinking the same thing.

We were starting a 10-day hunting trip into the front range of the Mackenzie Mountains. I'd been waiting five years for this day — to gain the adequate residency time required to get a permit for hunting big game animals here. I'd moved to Canada from Florida in 2007, going from working with TNC on coral reefs to vast, remote forests and tundra. The chance to hunt big game here was a childhood dream – chasing moose

through swamps and sheep around mountains. It was a nice perk of working for TNC this far North. Hunting also takes on a different context here as First Nation's people have relied on meat from hunting for generations, and some remote communities where TNC works maintain that strong connection to the land.

I started hunting at the age of four in the squirrel woods of Ohio with my dad. While people who aren't familiar with rifle calibers or butchering their own meat find it strange that I can be both a conservationist and a hunter, to me the two worlds mesh seamlessly. Hunting isn't just about killing or hanging a head on your wall. Or a competition to see who can wear the most camouflage clothing or drive the biggest truck.

For me, hunting is a way to spend time outdoors and develop a deeper connection with nature that relies on all of your senses to be awake and aware. It is an ultimate test of your abilities to survive in the wilderness, with proper planning and equipment, and to provide your own sustenance from the natural world. And what about that sustenance? Free-ranging, organic, lean, sustainable meat, often times harvested locally. Sustainable animal populations also rely on adequate food, clean water and plentiful habitat — three pillars of any working ecosystem, likely bringing those interested in pursuing hunting onside with conservation efforts, even if they don't realize it.

Hunting is also big business. The latest numbers compiled by Environment Canada in 1996 show $11 billion spent on nature related activities, including recreational hunting and fishing. The survey also reported 5% of the population identifying at "active hunters" and another 5% wanting to participate. A 2011 report in the U.S. pegged 90 million Americans taking part in hunting, fishing or wildlife viewing spending almost $145 billion or 1% of U.S. GDP.

Top of the list for most hunters are Dall sheep — a wily mountain ungulate that thinks it's fun to hang out on inaccessible cliffs above 6,000 feet. Dall sheep have eyesight equivalent to a human using 10x binoculars; apparently they can smell and hear, too. Most hunters pay upwards of $15,000 for a guided hunt into sheep country, but we'd spent the last 12 months poring over maps, preparing dehydrated food recipes and making gear checklists. I hiked to my TNC office with a 70-pound pack on my back for weeks. We were ready.

"While people who aren't familiar with rifle calibers or butchering their own meat find it strange that I can be both a conservationist and a hunter, to me the two worlds mesh seamlessly."

Our goal was to see a ram (before it saw us), stalk within rifle range and make a clean kill. We would break the animal into manageable parts, load it into our packs and head back to the lake — the only accessible place for a plane to extract us. Of course those packs were also carrying food, clothing, hunting equipment and emergency gear. Along the way, we hoped to see moose in the mountain valleys, wolves ranging in search of their next meal, mountain caribou dotting the lower elevations and even the occasional grizzly bear. We didn't plan on seeing other people.

After 10 days we returned to the lake exhausted, soaking wet, sore and mentally drained, looking for our plane. We saw sheep, and I even managed to make a little too much noise trying to stalk closer for a shot on a legal ram the last day. But living up to

the Dall's cunning reputation, he took flight and ran effortlessly over mountain ridges — ridges that would take us hours to climb.

Being in wilderness that large and untamed was a humbling experience, and it's hard to explain the satisfaction of completing such a trip even though we returned without firing a shot. We were doing much more than simply pursuing game; we were spending time outdoors, on our own in the elements, knowing full well we would be hungry, tired and likely disappointed by one of the wariest game animals in North America. That is why they call it hunting, and I wouldn't have it any other way.

Are you a hunter? Do you work in conservation? Email Mike with your story. **SC**

"Along the way, we hoped to see moose in the mountain valleys, wolves ranging in search of their next meal, mountain caribou dotting the lower elevations and even the occasional grizzly bear. We didn't plan on seeing other people."

Q&A
5 Questions for Australia's James Fitzsimons

By Darci Palmquist, senior science writer, The Nature Conservancy

Image: Mineral stains color a dry salt lake bed in the Great Western Woodlands of southern Western Australia. Comprising more then 39 million acres, The Great Western Woodlands is the largest temperate woodland and heathland left on earth. Image credit: Mark Godfrey/TNC.

When it comes to conservation, Australia has much to brag about — from it's far-reaching National Reserve System, which protects 13% of the country, to it's innovative work establishing Indigenous Protected Areas. But it's not aways easy to be on the leading edge. What is the status of some of Australia's recent projects, such as the creation of wildlife corridors, and how will they impact traditional conservation efforts? What does 21st century conservation look like in Australia?

James Fitzsimons, the Conservancy's director of conservation in Australia, stepped up to answer these questions and more.

Q: You've had two books come out recently — tell us about them. What do you hope their significance will be for conservation in Australia and beyond?

A: There's been a huge surge in interest in connectivity conservation in Australia over the last decade and in developing real, on-the-ground networks of conservation lands to do this. And working on this issue across the academic, government, and NGO sectors, I noted the big gap in understanding between those talking about these

initiatives in a policy or ecological sense and those who were actually running these initiatives on the ground. One of the key aims of publishing *Linking Australia's Landscapes: Lessons and Opportunities from Large-Scale Conservation Networks* was to bridge that gap. So we (myself and co-editors Ian Pulsford and Geoff Wescott) brought together the facilitators/coordinators of the 14 most advanced on-the-ground connectivity initiatives and asked them to document the history of the initiative, successes, constraints and directions for the future. These experiences were complemented by those of policy makers and organizations seeking to design and implement 'networks of networks' beyond the individual initiative, as well as broader perspectives from researchers in the fields of ecological and social sciences, governance and economics.

The other edited book, *Innovation for 21st Century Conservation*, originated from a symposium in early 2013. We wanted to document some of the most innovative approaches to conservation in Australia over the last 5 years or so and invited many of Australia's top conservation thinkers and 'doers' to contribute chapters. The authors came from the NGO, academic and government sectors and focused on the establishment, management, financing and policies of conservation lands (and landscapes) in the broadest sense. Many of the important lessons from these programs, particularly from government, never get documented publicly and as governments change and key staff move on, those lessons can often get lost and forgotten.

Q: Innovation is a theme here — can you give us an example of the innovative conservation science happening in Australia, and how it's making a difference?

A: Australia has long been an innovator in systematic conservation planning. What we probably haven't been as widely recognised for is that we are also innovators in policy and implementation in this field. The National Reserve System program, the Indigenous Protected Area program and the National Wildlife Corridors Plan are all examples of this. This has resulted in a doubling of the protected area estate on land in the past decade and a half. The principles of 'comprehensiveness, adequacy and representativeness' have provided the solid science unpinning but it has been the commitment of the governments, NGOs and Indigenous groups to work cooperatively that has made this happen.

"Australia has long been an innovator in systematic conservation planning. What we probably haven't been as widely recognised for is that we are also innovators in policy and implementation in this field."

Q: Australia is a world-leader in establishing protected areas, but some of these are now under threat by policy changes. What's happening and why?

A: You're right, Australia has been a leader in this field, and yes, in the last few years in particular, we've seen an increasing threat to protected area principles. Some state governments have been opening up national parks and other protected areas for exploitative activities which are totally at odds with these principles — cattle grazing with no ecological basis, recreational hunting, etc. On the water there have been cases of changing marine protected area boundaries to increase access to recreational fishing and

a recent attempt to disallow the recently-declared and ground-breaking Commonwealth marine reserve network in Federal Parliament.

Why is this happening? A good question. The reasons are multiple but I'd suggest strong lobbying by user groups, politics and perhaps not enough 'selling' of the benefits of protected areas to government and to the community have played a major part. What has been encouraging is the strong public backlash to some of these threats.

Q: What can Australia teach the world about conservation? And on the flip side, what do you think Australia could learn from other locations?

A: In terms of systematically creating reserve networks and connectivity conservation initiatives, we have been learning a lot and I think we have a lot of lessons that are highly applicable to other geographies. To some extent, documenting these experiences and lessons in the two books was a means to share these lessons with the world. But there is actually an increasingly healthy and important dialogue between connectivity initiatives in Australia and North America (such as Yellowstone to Yukon).

Q: What areas of scientific research does conservation in Australia need next?

A: Corridor and connectivity work is still a new and evolving field, so there are a number of research areas to pursue. Further research is needed to understand the social, political and economic dynamics of landscapes and communities. Improved knowledge of the social and demographic characteristics of those landowners participating in connectivity conservation initiatives and those that are not could provide important information and allow approaches to be tailored to attract landowners in the future and to enhance the long-term sustainability of connectivity groups and projects.

Long-term research and analysis of ecological, social, governance and land use attributes would enhance our understanding of the forces that shape multi-tenure conservation initiatives. Of particular interest is the identification of reasons for their persistence or failure. The impact that the failure of an established network may have on landowners involved is of particular interest because disenfranchisement may lead to negative outcomes for biodiversity conservation. Longer-term research would also enable a more thorough evaluation of the contribution of networks to biodiversity conservation, the ultimate reason for establishing such initiatives. SC

"The impact that the failure of an established network may have on landowners involved is of particular interest because disenfranchisement may lead to negative outcomes for biodiversity conservation."

Books

Linking Australia's Landscapes: Lessons and Opportunities from Large-Scale Conservation Networks. 2013. Eds. James Fitzsimons, Ian Pulsford, Geoff Wescott. Available from CSIRO Publishing.

Innovation for 21st Century Conservation. 2012. Eds. Penelope Figgis, James Fitzsimons, Jason Irving. Available freely online.

Bob Lalasz
PLoS ONE and the Panic Over Impact

By Bob Lalasz, director of science communications, The Nature Conservancy

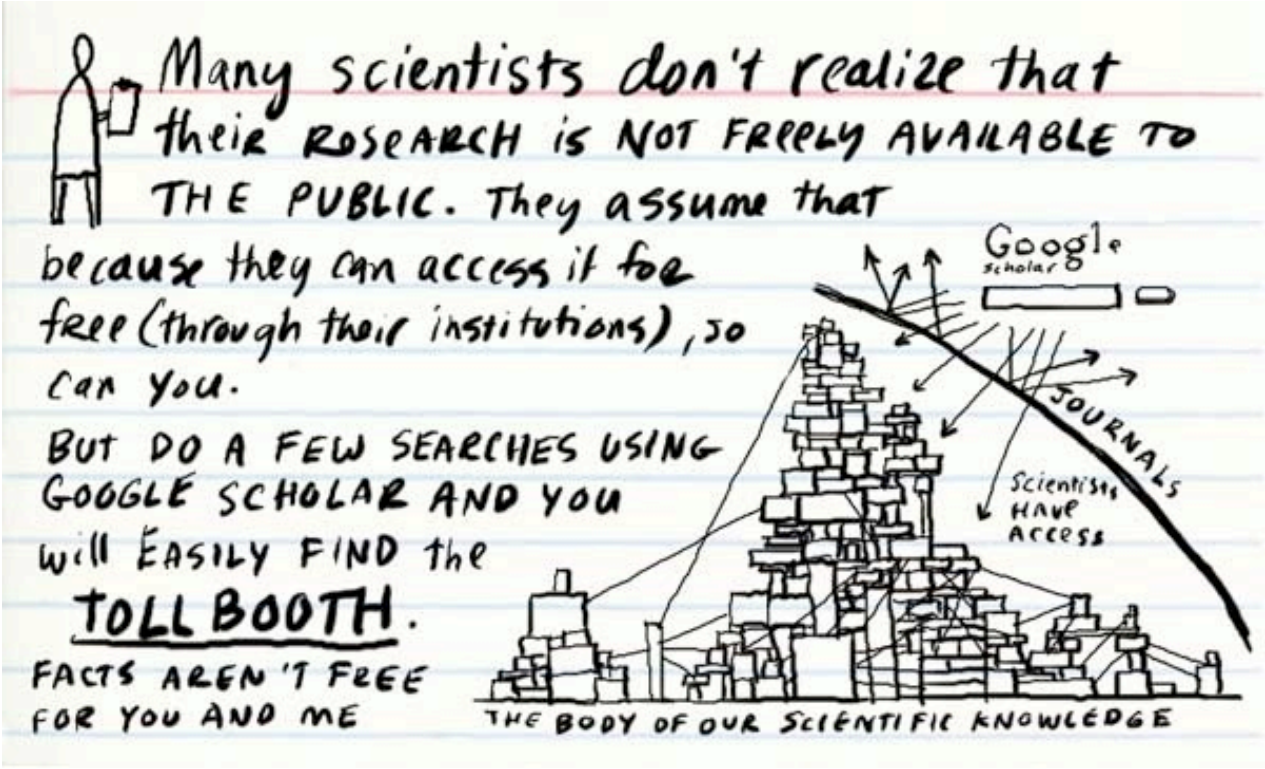

Image: Does your science have the impact you want it to have? Image credit: Flickr user Dave Gray via a Creative Commons license.

What is "impact" for science, anyway?

And could the ways we define "impact" explain why we have less of it than we think we should?

Case de jour: PLoS ONE, the world's largest scientific journal. Its 2012 "impact factor" (the most widely used measure of a journal's scientific influence — calculated by the number of citations a year's worth of its papers receive elsewhere, divided by the number of papers it published that year) dropped a whopping 16% from 2011's number, it was announced in June.

That magnitude of Journal Impact Factor (JIF) decline would be enough to make most scholarly publishers man the life rafts. Since publishing is so key to science, what makes up a scientific career — the hirings, promotions, tenure, grants — relies at least indirectly and many times directly on JIFs. So scientists need to publish in journals with relatively high impact factors…and hope those numbers don't drop before they're up for their next job.

If you're a scientist, you've almost certainly at least peeked at a journal's JIF before

submitting to it; you might even get a cash bonus when you publish to a high JIF one such as *Nature* or *Science*. No wonder the annual announcement of every journal's JIFs in June by Thompson Reuters, the official toter-up of the numbers, is followed in some circles like Selection Sunday for March Madness.

So it's a safe bet no champagne was popped in the PLoS ONE offices when their new JIF was announced. But scientists — including conservation scientists — weren't happy, either.

PLoS ONE — a free-to-read, online-only, fast-turnaround, data- and graphics-friendly science journal whose 2006 debut shook up a scholarly culture used to snooty editors, $1,000-and-up annual journal subscriptions and glacial manuscript reviews — has become a favorite submission destination for many researchers who have papers that could make a splash.

I recommend it to Conservancy scientists for articles that have color graphics and potential media impact. PLoS One does graphs and charts well, is followed closely by science media, and has a competent and aggressive media relations staff. In addition, it doesn't cost much to publish there, and even less for developing country authors.

Unfortunately, PLoS ONE's JIF will continue to drop because of the very way it does business, according to Phil Davis, a publishing analyst and contributor to the group blog Scholarly Kitchen.

Davis argues that PLoS One's first strong JIF in 2009 (4.351) brought a slew of submissions in 2010 from researchers looking to capitalize on that number. And since PLoS ONE now publishes tens of thousands of those submissions annually (23,464 last year, to be precise), it doesn't have the tight editorial selectivity of a *Nature* or a *Science* necessary to ensure it only selects potentially high-citation papers. So that Impact Factor will keep dropping, because any one high-impact paper will be lost in a sea of thousands.

In essence, Davis is saying, PLoS ONE will continue to be victimized by its early success and its all-comers philosophy. He predicts a decline in megajournals like PLoS ONE and a return to discipline-based journals that have sped up their review cycles and added altmetrics without corresponding declines in JIF.

"Since publishing is so key to science, what makes up a scientific career — the hirings, promotions, tenure, grants — relies at least indirectly and many times directly on JIFs [Journal Impact Factor]."

Mother of jargon, is this the end of PLoS ONE?

A better question might be: Is this the end of JIF?

JIF's value has been debated for years, but it's never been under such systematic attack as now. A statement signed in May by more than 8,000 scholars and 300 institutions called the San Francisco Declaration on Research Assessment (DORA) calls for an end to using journal-based metrics such as JIF in decisions about scientific

funding, appointments and promotions.

But here's the shock: Now, there's a growing body of evidence that JIF isn't a particularly good measure of impact — and might even contraindicate it.

As George Lozano writes for the London School of Economics blog, the strength of the relationship between a journal's Impact Factor and any one of its individual paper's citations rates has been dropping since 1990 — when the Internet began untethering papers from journals and search made journal provenance largely moot.

And get this: Lozano says that, since 1991, the proportion of top papers not published in top JIF journals is declining.

"If the pattern continues," he writes, "the usefulness of the IF will continue to decline, which will have profound implications for science and science publishing. For instance, in their effort to attract high-quality papers, journals might have to shift their attention away from their IFs and instead focus on other issues, such as increasing online availability, decreasing publication costs while improving post-acceptance production assistance, and ensuring a fast, fair and professional review process."

Bjorn Brembs, Katherine Button and Marcus Munafo top Lozano, with a long takeout on JIF in *Frontiers in Human Neuroscience* that blames journal rank for everything from the rise in scientific retractions and the decline effect to the unwillingness of many publishers to make their journals open-access or to cut subscription prices.

And if that evil list isn't enough, ranking journals is just bad scientific practice, they argue: "Much like dowsing, homeopathy or astrology, journal rank seems to appeal to subjective impressions of certain effects, but these effects disappear as soon as they are subjected to scientific scrutiny."

Think about that before you go back to the Journal of Obscurity and Editorial Neglect.

"But here's the shock: Now, there's a growing body of evidence that JIF isn't a particularly good measure of impact — and might even contraindicate it."

As I do a dozen or more times each year, I worked recently with a scientist to develop a communications plan for one of her new papers. She chose to publish it in a specialty journal that had the practitioner readership she wanted for her work; but that journal was print-based and subscription only, with very limited online-first features that we had to pay $3,000 to secure.

The journal also had zero resources for media relations, so we had to generate any coverage for it ourselves. Worst of all, it took nine months between the time the paper had been accepted and publication — it felt as if single-celled organisms had evolved into mammals during the interim.

And communication from the journal's editorial staff about when it finally would

appear was non-existent. The paper went virtually uncovered by media. We'll have to wait a few years to find out about scholarly impact. It's fair to say the scientist was disappointed in the experience.

For my money, if you're a conservationist worried about PLoS ONE's JIF, or JIF at all, that's a sign you have bigger issues to worry about.

PLoS ONE is still a premier journal for communicating your work — especially interdisciplinary and media-worthy work — as opposed to using it to get validated. Conservation science has enough trouble getting attention; we don't need to place imaginary boulders in the pathways we have.

Other interesting recent links on JIF and scientific impact:

Paul Wouter at The Citation Culture says there are a lot of better journal impact indicators than JIF, but that they shouldn't rule the world, either.

What would a metric that evaluated the impact of research not just on science, but on practice and society look like? Birge Wolf and co-authors take a crack at it in the latest issue of GAIA.

There's also always social media if you want to *really* make an impact. **SC**

Note: This article originally appeared on Cool Green Science.

"Conservation science has enough trouble getting attention; we don't need to place imaginary boulders in the pathways we have."

15 Seconds of Fame
Steven Victor

Life in Palau is tied to the sea. But for the Conservancy's deputy director of conservation in this remote island country, a background in farming and gardening is key to helping save local marine resources. Meet Steven.

Image: Steven Victor, the Conservancy's deputy director of conservation in Palau.

INQUISITION: I'm told that as a young boy I was always asking questions. I was always interested in finding an answer to a question and I guess this led me to a career in science. What inspired me to a career in conservation are the communities that I started working with as a scientist. I learned a lot of traditional conservation knowledge through working with communities by sharing the science I knew, and that inspired me to help communities improve conservation and management of the resource for which their livelihoods depend upon.

GROWING: I've been actively gardening for about 5 years. I garden in the morning and after work and on weekends, that's where I spend most of my time. My garden is fairly small. Most of the vegetables I grow are in containers — tomatoes, eggplant, pechay (Chinese cabbage) and beans — as the soil where I live is not very good. Out in the backyard, I grow bananas (two varieties), pineapples and soursop. Most of the plants I grow are flowers called desert rose or *Adenium obesum*.

I like gardening because I like to see things grow. It's a lot of pleasure seeing something grow from a seed to a plant that bears fruits. It's very much the same as growing my kids and that is why I love spending time with my kids. I also believe that

this is a mentality we need to instill in fishermen, that we need to take care of the reefs just as we take care of our gardens — we harvest what we grow. While I don't advocate for raising fish, the concept of taking care of the reef by leaving the fish to breed and grow needs to be planted in fishermen's mind and behaviors.

TRENDING: I think what we are doing in Palau now — the data-poor stock assessment technique, which allows for assessing fisheries at low cost and working with fishermen — is providing the needed science that supports community-based marine conservation and fisheries management.

THREE LITTLE PIGS: With the data-poor stock assessment technique, the information we've collected so far indicates that most of Palau's fish are being caught just before they have grown big enough to reproduce. To help illustrate this concept, we came up with the analogy of pigs — many people here raise chickens or pigs, so they know that a one-year-old sow can have two litters a year, each with half dozen piglets or more. So why would you slaughter a pig before she reaches maturity? The same is true with fish. Using this analogy has really helped get the message across to fishermen.

ON THE JOB: A typical week for me is just getting from meeting to meeting. While not always enjoyable at times, it's important for building partnerships, providing information that advances conservation, and gaining trust from communities and fishermen that helps me to work with them on conservation issues and strategies. When not in a meeting, I am talking with one of my closest friends discussing conservation and science and debating the best approaches for implementation.

MESSAGE IN A BOTTLE: Palau can offer the world lessons on valuing the marine environment as an asset for balancing economic development and ensuring that the resource being enjoyed today will be the same or better for future generations. SC

Interview by Darci Palmquist. Know someone we should feature in this column? Please email her with comments or suggestions.

Blog Reel

Voices from the Conservancy's science blog, *Cool Green Science*. Interested in contributing? Contact Matt Miller.

"We have been invited into the home of Allie and Bama, and it has been the best unscripted reality show I've ever seen!"

— **Jeff DeQuattro** in *Osprey Cam: Reality TV Featuring Our Wild Neighbors*

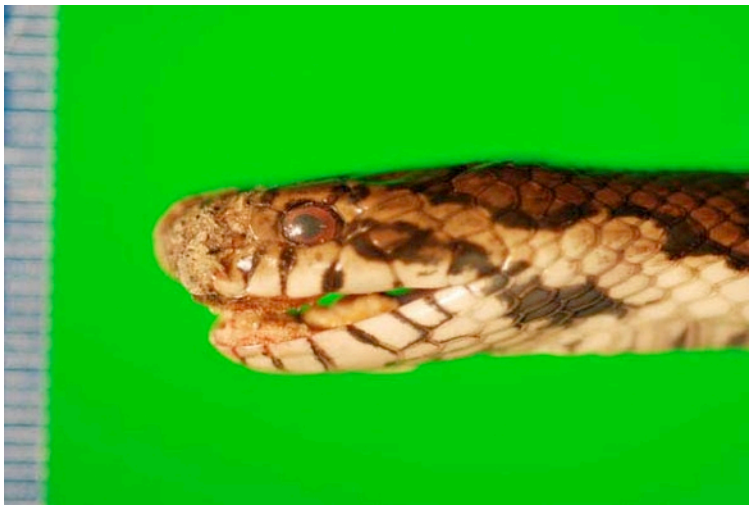

Image: A milk snake showing signs of fungal and bacterial infections. By D.E. Green, USGS National Wildlife Health Center.

"While studying timber rattlesnake movement patterns and habitat use in Vermont, researchers made a surprising discovery: snakes covered in lesions, particularly around their faces."

— **Matt Miller** in *Snake Fungal Disease: The White-Nose Syndrome for Reptiles?*

"If there were actuarial tables for species survival, horseshoe crabs would have the world's lowest species survival insurance premiums. They have already made it through asteroids hitting the earth, at least three ice ages, changes in sea level, and large fluctuations in atmospheric CO_2. "

— **Craig Leisher** in *The Horseshoe Crab: World's Most Successful Animal*

"When the world gets warmer, what happens to bison? And what does that imply for other grazing animals, like the 100 million cattle that graze on U.S. grasslands?"

— **Joe Craine** in *Climate Change and the Future of Bison*

"What is 'impact' for science, anyway? And could the ways we define 'impact' explain why we have less of it than we think we should?"

— **Bob Lalasz** in *The Cooler: PLoS ONE and the Panic Over Impact*

Science Short
Ant Work

Mersch, D.P. et al. 2013. Tracking Individuals Shows Spatial Fidelity Is a Key Regulator of Ant Social Organization. Science, 340, 1090-1093.

Ant colonies have the ability to solve complex problems like transporting food and caring for the young. But how do ants decide who does what?

A recent study used computer tracking to follow individual ants in a colony. It recorded more than 2 billion ant positions over 41 days.

The study found that ants divide the work into nursing, cleaning and foraging.

These groups also reflect the career progression of an ant. The average age of the nurse ants is younger than the cleaners, who are in turn younger than the foragers. The older the ant, the more likely she is to be a forager. And it is always a "she."

Like honeybees, ant workers are sisters whose mother is the queen. Male ants (drones) mate with the queen and have short…uh…purpose-driven lives. Ants are very similar to honeybees in how they organize themselves according to age.

As ants get older, they not only change jobs but they also change locations, with younger ants living near the babies and older ants living near the exits. Within the nurse and forager groups, ants form subgroups that specialize in one physical area.

So the ants you see carrying a dead bug back to their colony are likely to be a group of sisters born about the same time who cover the same area as foragers. An ant colony is a sisterhood, segregated by age and neighborhood who decide themselves what they should do and where they should live. SC

— **Craig Leisher**, senior social scientist, The Nature Conservancy

Announcements

Science Innovation and Achievement Award

By Peter Kareiva and Bill Ginn

TNC has always been science-based, and many of TNC's most effective conservation strategies have come out of science advances. These include everything from environmental flows, to water funds, development by design, and coastal resilience. We are launching a new annual award to recognize scientists at TNC who exemplify science innovation. Candidates can be nominated by any senior manager within TNC and the nominating senior manager need not be a supervisor of the person they nominate. The criteria used to select the winner entail innovation, publication, and potential (or realized) impact.

The nomination should consist of a short letter (one page) that indicates why the science is so important, as well as a copy of candidate's resume and PDFs or links to one or two publications that report on the scientific foundations behind the contribution. The nominations will be reviewed by the Chief Scientist and the Chief Conservation Officer, who will jointly make the decision. A modest monetary award of $2,000 will accompany the recognition. Submissions due September 30. **SC**

Articles Welcome

Submitted by Rebecca Benner

Environment: Science and Policy for Sustainable Development welcomes articles from scientists, policymakers, research-scholars, and professors working in the environmental sustainability field to publish high quality peer-reviewed papers. *Environment* analyzes the problems, places, and people where environment and development come together, illuminating concerns from the local to the global. More readable than specialized journals and more timely than textbooks, *Environment* offers peer-reviewed articles and commentaries from researchers and practitioners who provide a broad range of international perspectives. A primary goal is to convey technical information and at-the-horizon ideas in a way that is understandable to those who are unfamiliar to the topic.

Completed articles are typically 3,000-5,000 words plus endnotes and sidebar boxes. We encourage the use of tables and graphs to illustrate points, as well as sidebar boxes to flesh out details or examples. Visit the website for more information and to submit your paper today. **SC**

Access to Science Journals Working Again

Submitted by Jon Fisher

For the past few months we have been experiencing problems with access to some of our science journals. Due to the hard work of Kyle Burford (TIS) and Lynne Eder (Central Science), these issues have been resolved. You can now access 738 journals by name via this page on Connect.

If you do not see a journal listed that you think we should have access to, please contact Lynne Eder. If any of the links on the Connect page do not work, please email Kyle Burford and Jon Fisher. If you can't get access to an article you need, try searching Google Scholar (which sometimes has copies of articles that aren't open access). You can also contact your local library; many libraries offer access to journals online to patrons who are physically in the library building and your library may have access to journals that TNC does not. **SC**

December 10-12, 2013: All Science Conference for Nature and People Santa Clara, CA

Submitted by Ryan Surber

Conservation today demands working in landscapes and seascapes that cross the spectrum of human uses and impacts, and range from local to global scales. The Nature Conservancy's Global Challenges Global Solutions framework provides an approach for working across those systems and scales to advance conservation for both nature and people. Science is integral to that approach. In December 2013, the Conservancy will convene conservation scientists, philanthropists, and environmental thought leaders to explore the existing science and explore innovative ways to select and design transformative conservation strategies, advance conservation efforts, and measure the effectiveness of investments in conservation. The 2013 All Science Conference for Nature and People will give us an opportunity to discuss, debate, and advance the science foundations of conservation in the 21st century.

This 3-day conference, hosted by TNC Chief Scientist Peter Kareiva and local host, Scott Morrison, will feature plenary sessions by CEO and President Mark Tercek, and CEO and President of the Wildlife Conservation Society, Dr. Christian Samper. In addition, TNC and guest scientists/practitioners will hold sessions on innovations in field work and advances in conservation. Please submit presentation proposals for consideration by the All Science conference committee. **SC**

New Conservancy Publications

Conservancy-affiliated authors highlighted in bold.

Please send new citations and the PDF (when possible) to: pkareiva@tnc.org and rlalasz@tnc.org. Please include "Chronicles Citation" in your subject line so we don't miss it.

Some references also contain a link to the paper's abstract and/or a downloadable PDF of the paper. When open source or permitted by journal publisher, these PDFs are being stored on the Conservation Gateway, which also is keeping a running list of Conservancy authored science publications since 2009.

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